MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

EEL1196 – INSTRUMENTATION & MEASUREMENT TECHNIQUES

(All Sections / Groups)

11 MARCH 2020
9:00 A.M – 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of 6 pages including cover page with 4 Questions only.
2. Attempt **ALL FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) What is the purpose of a signal conditioning element in measurement systems? Give an example of a device or component that is classified as a signal conditioning element. [3 marks]

(b) (i) Distinguish between the terms 'resolution' and 'sensitivity'. [4 marks]

(ii) A thermocouple indicates an output voltage of 30mV for a detected temperature of 50°C; and 70mV when the temperature is 75°C. Determine the sensitivity of the thermocouple. [3 marks]

(c) A circuit is as connected in **Figure Q1(c)**. It is given that:

$$R_1 = 1\text{k}\Omega \pm 5\%,\ R_2 = 3\text{k}\Omega \pm 10\% \text{ and } E = 15\text{V} \pm 3.5\%$$

Calculate the total current, I as well as its % relative limiting error. [9 marks]

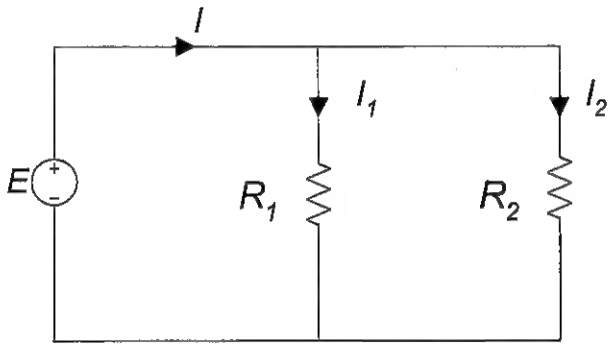

Figure Q1(c)

(d) The energy of a photon is related to its speed, c, and wavelength, λ, by the following equation:

$$E = (hc)/\lambda$$

where h is Planck's constant. Find the dimension and base units of h. [6 marks]

Continued...

Question 2

(a) Name the 3 different torques required for the operation of indicating instruments and describe the purpose(s) of each torque. [5 marks]

(b) A permanent magnet moving coil (PMMC) instrument has coil dimensions of 15cm × 8cm with 20 turns and spring constant value, $k = 2.5 \times 10^{-6} \frac{\text{Nm}}{\text{degree}}$. The coil produces an angular deflection of 90° when a current of 6mA flows through it. Calculate the flux density required in the air gap. [4 marks]

(c) A shunt resistor R_S is connected across a direct-current (DC) moving-iron ammeter as shown in **Figure Q2(c)**. It is given that the meter resistance, $R_M = 900\Omega$. Calculate the value of R_S required to extend the current range from 100mA to 1A. Assume that meter current, $I_M = 100\text{mA}$ and $I = 1\text{A}$. [4 marks]

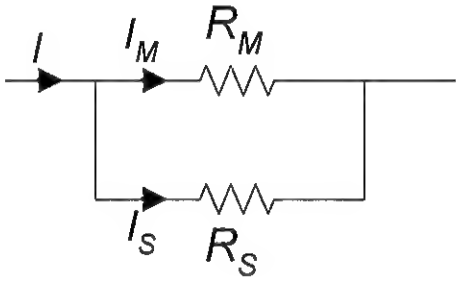

Figure Q2(c)

(d) For magnetic testing purposes, there are both advantages and disadvantages of using ring sample and bar sample, state the advantages and disadvantages of using each of these two sample types. [4 marks]

(e) An iron ring fluxmeter, with a current of 10A flowing through its magnetizing winding of 20mm mean diameter and a cross section area of 25mm². It has a magnetizing winding of 400 turns in its search coil. If the flux linking with the search coil is 50 x10^{-6}wb, find the relative permeability of the specimen. ($\mu_o = 4\pi \times 10^{-7}$ H/m) [8 marks]

Continued...

Question 3

(a) A Wheatstone bridge is shown in **Figure Q3(a).** The values of the resistors are given as $R_1 = 4\text{k}\Omega$, $R_2 = 50\text{k}\Omega$, $R_3 = 2\text{k}\Omega$, but the value of R_4 is currently unknown. Find the value of R_4, if the circuit is in balanced condition. [4 Marks]

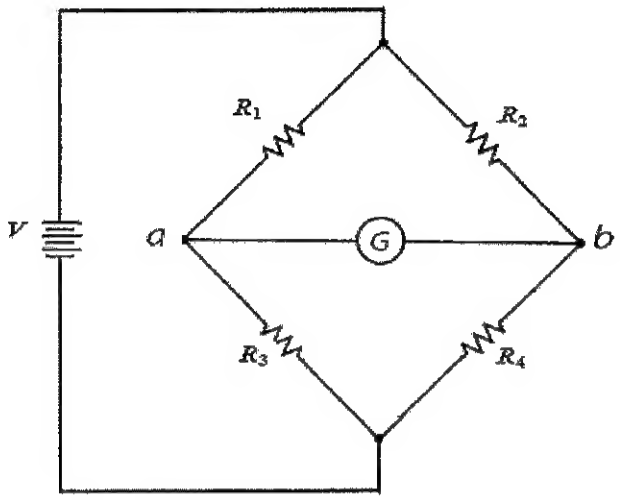

Figure Q3(a)

(b) For the given AC circuit shown in **Figure Q3(b),** in the two arms of this bridge circuit, the resistors and capacitors are in parallel. When the bridge is balanced, operating frequency is found to be 500Hz, if $R_1 = 2\text{k}\Omega$, $R_3 = 1\text{k}\Omega$, $R_4 = 500\Omega$ and $C_1 = 0.5\mu\text{F}$. Derive and find the values of R_p, C_p and the D factor of this circuit.

[10 marks]

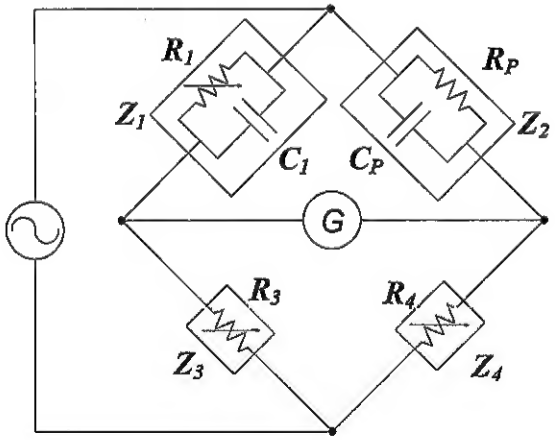

Figure Q3(b)

Continued...

(c) The **Figure Q3(c)** shows an AC Maxwell Wien Bridge, if C_1 = 0.08μF is in parallel with a resistor R_1 = 100Ω in arm AB. In arms BC and AD, R_2 = 1.25kΩ and R_4 = 80Ω. If the bridge is balanced under these conditions, derive the equations and find the values for the inductor L_s and resistor R_s in arm CD.

[11 marks]

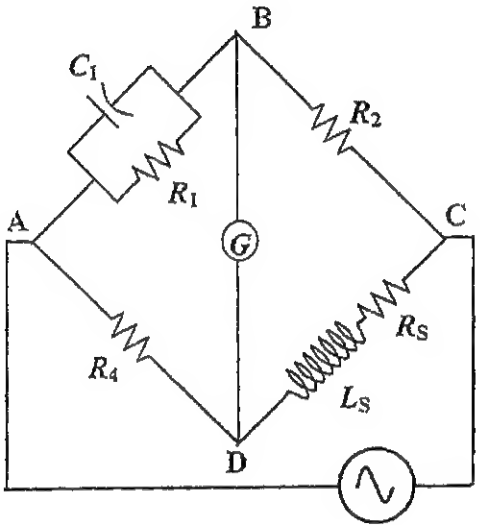

Figure Q3(c)

Continued...

Question 4

(a) An electrodynamometer-type wattmeter has a pressure coil resistance, $R_P = 3.2\text{k}\Omega$. Calculate the percentage error of the wattmeter reading if the pressure coil is connected **after** the current coil, as shown in **Figure Q4(a)**. Given the load current, $I_L = 15\text{A}$ and load voltage, $V_L = 150\text{V}$ and power factor, $\cos\varphi = 0.8$. [4 marks]

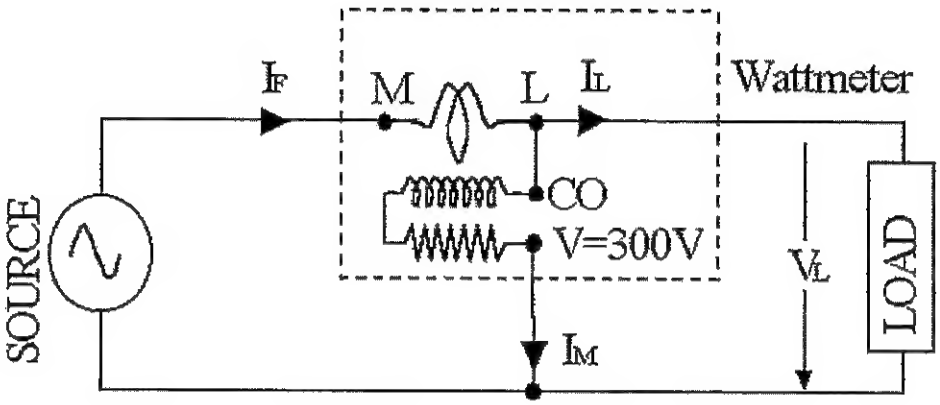

Figure Q4(a)

(b) The power in a balanced 3-phase star-connected load is measured by using the two-wattmeter method.

(i) Write the formulas for each wattmeter reading, P_1 and P_2 as well as the total power, P_T. [3 marks]

(ii) Determine the readings of P_1, P_2 and P_T if the line voltage, $V_L = 250\text{V}$ and line current, $I_L = 20\text{A}$ with power factor, $\cos\varphi = 0.65$. [3 marks]

(c) An energy meter has a constant of 100 revolutions per kilowatt-hour (revs/kWh). Calculate the number of revolutions made by the disc in 20 minutes when measuring the energy consumed by a single-phase load carrying 20A at 220V and power factor of 0.75. [3 marks]

(d) A resistance-temperature detector (RTD), with the temperature-resistance relationship has a temperature coefficient of $\alpha_{20°\text{C}} = 0.01/°\text{C}$, given that the resistance at 20°C is 50Ω.

(i) Determine the RTD resistance at 50°C. [4 marks]

(ii) The RTD is then placed in an oven set at constant temperature of 100°C, with a dissipation constant of 50mW/°C and the current supplied to the sensor is 20mA. Calculate both the resistive value of RTD in the oven, and the temperature value as indicated on the RTD. [8 marks]

End of Paper